

SMEI Electromagnetic Compatibility

Test Plan

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SMEI Electromagnetic Compatibility Test Plan

1. Introduction

This document describes the requirements and procedures for Electromagnetic Compatibility testing of the Solar Mass Ejection Imager (SMEI) instrument, which will form part of the Coriolis Mission spacecraft.

2. Applicable Documents

The following documents in their latest issue form part of this specification to the extent referenced herein. In the case of conflict between this document and any referenced document, this EMC Test Plan shall take precedence.

MIL-STD-461D "Requirements for the Control of Electromagnetic Interference Emissions and Susceptibility", 11 Jan 1993.

MIL-STD-462D "Test Method Standard for Measurement of Electromagnetic Interference Characteristics", 11 Jan 1993.

3. The SMEI Instrument

3.1 Introduction

The SMEI instrument comprises a Data Handling Unit (DHU) and three optical CCD Camera Units. The DHU consists of two fully redundant systems (DHU A and DHU B) each of which has independent power, command and telemetry interfaces with the spacecraft. The only connectors interfacing with the spacecraft are located on the DHU. Each Camera is connected to the DHU via two intra-instrument cable harnesses, one for power and one for signals. Grounding points are provided on the DHU and on each Camera.

The instrument Electrical Ground Support Equipment (EGSE) comprises a PC fitted with a MIL-STD-1553B interface board, together with a small Spacecraft Simulator unit which provides relay command outputs, 1 Hz sync outputs and 28 V power to the instrument.

3.2 Size and Mass

Approximate dimensions and masses of the components of SMEI are given in Table 3.1.

| | Dimensions (mm) | Mass (Kg) |
|----------------------------|-------------------------|-------------|
| DHU | 310 x 270 x 95 | 7.0 |
| Cameras (each) | 500 x 460 x 410 | 7.6 |
| Intra-Instrument Harnesses | Various lengths ~ 1.5 m | Total ~ 1.5 |

Table 3.1 – Approximate Dimensions and Masses of SMEI Units

3.3 Electrical Interfaces and Connectors

A block diagram showing the electrical connections between the DHU, spacecraft and cameras is given in Figure 3.1.

The types and functions of the connectors mounted on the DHU are listed in Table 3.1.

Pin allocations for connectors J1 and J2 which, together with the MIL-STD-1553B busses, form the interface with the spacecraft are given in Tables 3.2 and 3.3.

| Connector | Type | Function |
|-----------|------------------|--|
| J1 | SND15M | Spacecraft 28V A and B supplies |
| J2 | SND15F | Spacecraft relay commands & 1Hz sync |
| J3 | SND25F | Test Connector (not used during EMC tests) |
| J4 | SDD62F | Camera 1 signals |
| J5 | SDD62F | Camera 2 signals |
| J6 | SDD62F | Camera 3 signals |
| J7 | SDD26F | Camera 1 power |
| J8 | SDD26F | Camera 2 power |
| J9 | SDD26F | Camera 3 power |
| J10 | Trompeter BJ3150 | MIL-STD-1553B Bus, DHU A, Ch A |
| J11 | Trompeter BJ3150 | MIL-STD-1553B Bus, DHU A, Ch B |
| J110 | Trompeter BJ3150 | MIL-STD-1553B Bus, DHU B, Ch A |
| J111 | Trompeter BJ3150 | MIL-STD-1553B Bus, DHU B, Ch B |

Table 3.1 – SMEI DHU Connectors

| Pin Number | Signal Name | Description |
|------------|----------------|---------------------------|
| 1 | SC_POWER_A+ | Spacecraft 28V A positive |
| 2 | SC_POWER_A+ | Spacecraft 28V A positive |
| 3 | SC_POWER_A_RET | Spacecraft 28V A return |
| 4 | SC_POWER_A_RET | Spacecraft 28V A return |
| 5 | SC_POWER_B+ | Spacecraft 28V B positive |
| 6 | SC_POWER_B+ | Spacecraft 28V B positive |
| 7 | SC_POWER_B_RET | Spacecraft 28V B return |
| 8 | SC_POWER_B_RET | Spacecraft 28V B return |
| 9 | Not used | |
| 10 | Not used | |
| 11 | Not used | |
| 12 | Not used | |
| 13 | Not used | |
| 14 | Not used | |
| 15 | J1_SCREEN | DHU structure |

Table 3.2 – SMEI Power Interface Connector J1

| Pin Number | Signal Name | Description |
|------------|-------------------------|---------------------------------|
| 1 | 1_HZ_A | 1 Hz sync to DHU A |
| 2 | 1_HZ_A_RET | 1 Hz sync return to DHU A |
| 3 | Not used | |
| 4 | Not used | |
| 5 | Not used | |
| 6 | RELAY_CMD_SEL_A | Switches on and initiates DHU A |
| 7 | RELAY_CMD_SEL_B | Switches on and initiates DHU B |
| 8 | RELAY_CMD_POWER_OFF | Switches off both DHUs |
| 9 | 1_HZ_B | 1 Hz sync to DHU B |
| 10 | 1_HZ_B_RET | 1 Hz sync return to DHU B |
| 11 | Not used | |
| 12 | RELAY_CMD_SEL_A_RET | Relay command return |
| 13 | RELAY_CMD_SEL_B_RET | Relay command return |
| 14 | RELAY_CMD_POWER_OFF_RET | Relay command return |
| 15 | J2_SCREEN | DHU structure |

Table 3.3 – SMEI Discretes Interface Connector J2

4 Test Configuration

The DHU and three Cameras shall be installed within the shielded chamber of the EMC test facility and the units shall be connected together using the flight intra-instrument cable harnesses. Each unit shall be grounded by means of a separate bonding strap.

The EGSE shall be installed outside the shielded chamber and screened cable harnesses, together with appropriate filtering at the chamber walls, shall be used for the connections between J1, J2, J10, J11, J110 and J111 on the DHU and the EGSE.

28 V power shall be supplied to the instrument from a standard power in the test facility and not from the SMEI EGSE.

Maximum operating power at 28 V is approximately 80 W.

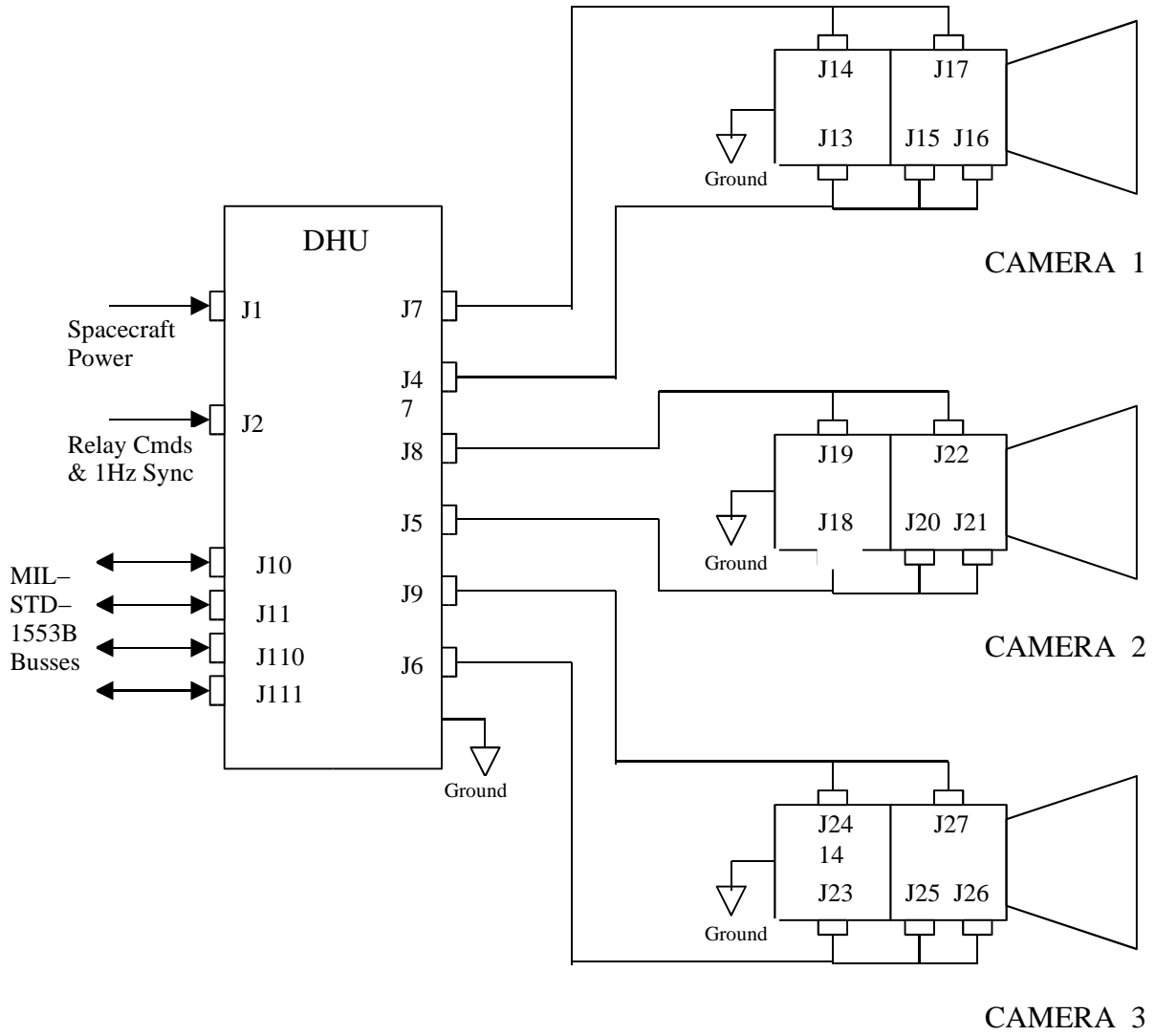


Figure 3.1 – Electrical Interconnections between the DHU, Spacecraft and Cameras

5. Test Specifications and Methods

5.1 Emission

5.1.1 Conducted Emissions

5.1.1.1 Conducted Emissions, Power Leads

The instrument shall be tested according to the procedures and requirements of MIL–STD–461D/462D CE102, over the range 10 kHz to 10 MHz.

Each 28V supply lead (A and B) and return on connector J1 shall be tested.

For the duration of the test, the SMEI instrument and EGSE will be configured and operated as follows:

- Camera Doors will be in *closed* position.
- The appropriate DHU (A or B) will be activated, depending on the supply lead being tested.
- The instrument will be operated in *Observing Mode*, with all three cameras taking exposures at the normal 4s cadence.
- The EGSE will be used to acquire and record telemetry data via the appropriate MIL–STD–1553B bus interface at the normal 64 kbps data rate.

5.1.2 Radiated Emissions

5.1.2.1 Radiated Emissions, Magnetic Field

Not required (TBC).

5.1.2.2 Radiated Emissions, Electric Field

The instrument shall be tested according to the procedures of MIL–STD–461D/462D RE102, over the range 10 kHz to 40 GHz. Above 30 MHz the test shall be performed for both vertically and horizontally polarised fields.

Radiated emissions limits are as for RE102, Navy and Air Force (External) **except that, in order to ensure compatibility with the rest of the Coriolis payload and spacecraft, reduced emissions limits apply at specific notch frequencies as listed in Tables 5.1 and 5.2.**

At frequencies other than those listed in Tables 5.1 and 5.2, the emissions limit in the range 18 to 40 GHz shall be 69 dB μ V/m.

The overall emissions limits for SMEI are shown in Figure 5.1.

| | | | | | |
|--|-------|-------|-------|-------|--------|
| Centre Frequency (GHz) | 6.8 | 10.7 | 18.7 | 23.8 | 37.0 |
| Bandwidth (MHz) | 125.0 | 300.0 | 750.0 | 500.0 | 2000.0 |
| Emissions Limit (dBμV/m) | 6.34 | 14.3 | 23.9 | 24.3 | 35.3 |

Table 5.1 – Emissions Limits and Bandwidths for WindSat Radiometers

| Receiver | Centre Freq (MHz) | Emissions Limit (dB μ V/m) | 3 dB Bandwidth (MHz) |
|--------------|-------------------|--------------------------------|----------------------|
| Range Safety | 416.5 | 24.6 | 0.1 |
| C-Band | 5690.0 | 50 | 14 |
| SGLS | 1771.7 | 7 | 10 |
| GPS | 1575.8 | 27 | 100 |

Table 5.2 – Emissions Limits and Bandwidths for S/C and L/V Receivers

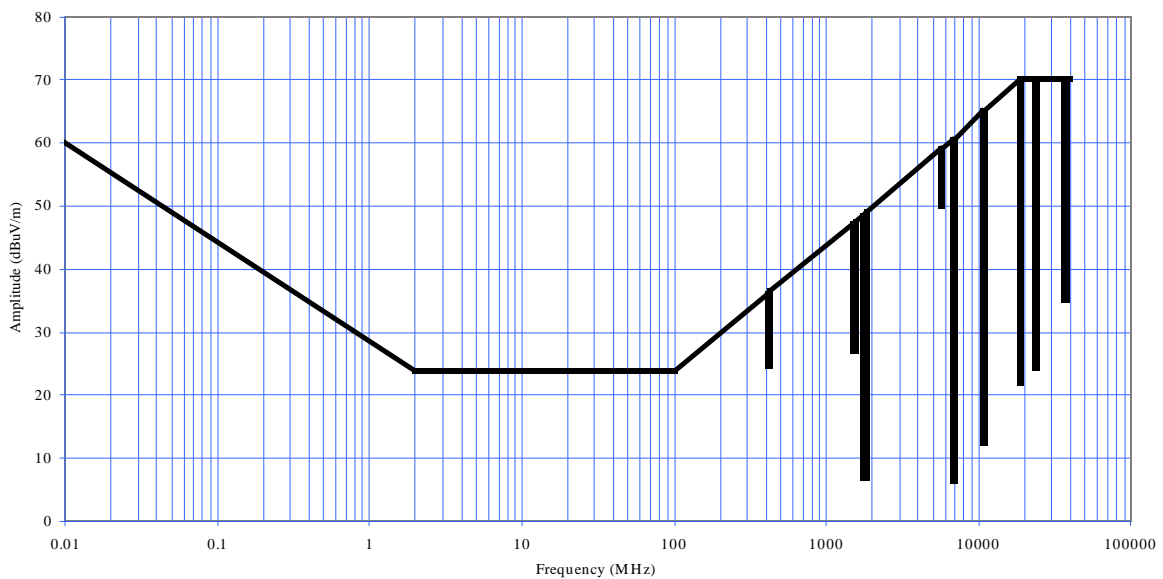


Figure 5.1 – Modified RE102 Emissions Limits

The DHU and one Camera shall be located as close together as practicable in the test set-up and the antenna in use shall be at a distance of approximately 1 m from the connector face of the DHU and from the Strong-Box of the Camera.

The test shall be performed using either DHU A or DHU B, **but not both**.

For the duration of the test, the SMEI instrument and EGSE will be configured and operated as follows:

- Camera Doors will be in *open* position, with the baffle apertures covered by protective bagging.
- Camera Shutters will be in *open* position.
- The instrument will be operated in *Observing Mode*, with all three cameras taking exposures at the normal 4s cadence.
- The EGSE will be used to acquire and record telemetry data via the appropriate MIL-STD-1553B bus interface at the normal 64 kbps data rate.

5.2 Susceptibility

5.2.1 Conducted Susceptibility

5.2.1.1 Conducted Susceptibility, Power Leads

The instrument shall be tested according to the procedures and requirements of MIL–STD–461D/462D CS101, over the range 30 Hz to 50 kHz.

The test shall be performed on 28V A supply input only, with DHU A activated. 28V B supply and DHU B shall **not** be tested.

For the duration of the test, the SMEI instrument and EGSE will be configured and operated as follows:

- Camera Doors will be in *closed* position.
- The instrument will be operated in *Observing Mode*, with all three cameras taking exposures at the normal 4s cadence.
- The EGSE will be used to acquire and record telemetry data via the appropriate MIL–STD–1553B bus interface at the normal 64 kbps data rate.
- SOH data will be monitored on the EGSE in order to verify that there is no unexpected response, malfunction or degradation in performance of the instrument.

Subsequent to the test, a representative sample of recorded science data will be examined to verify that there is no degradation in performance of the CCD cameras.

Note: The configuration with the Camera Doors closed will result in the CCD images being only dark charge, which is the most sensitive case for detecting degradation in performance of the cameras.

5.2.1.2 Conducted Susceptibility, Bulk Cable Injection

The instrument shall be tested according to the procedures and requirements of MIL–STD–461D/462D CS114 (space), over the range 10 kHz to 200 MHz.

The test shall be performed on each cable bundle interfacing to each connector at the DHU, i.e. on connectors J1, J2, J4, J5, J6, J7, J8, J9, J10, J11, J110 and J111 (TBC).

The test shall be performed with DHU A activated only. DHU B shall **not** be tested.

For the duration of the test, the SMEI instrument and EGSE will be configured and operated as follows:

- Camera Doors will be in *closed* position.
- The instrument will be operated in *Observing Mode*, with all three cameras taking exposures at the normal 4s cadence.
- The EGSE will be used to acquire and record telemetry data via the appropriate MIL–STD–1553B bus interface at the normal 64 kbps data rate.
- SOH data will be monitored on the EGSE in order to verify that there is no unexpected response, malfunction or degradation in performance of the instrument.

Subsequent to the test, a representative sample of recorded science data will be examined to verify that there is no degradation in performance of the CCD cameras.

Note: The configuration with the Camera Doors closed will result in the CCD images being only dark charge, which is the most sensitive case for detecting degradation in performance of the cameras.

5.2.2 Radiated Susceptibility

5.2.2.1 Radiated Susceptibility, Magnetic Field

Not required (TBC).

5.2.2.2 Radiated Susceptibility, Electric Field

The instrument shall be tested according to the procedures and requirements of MIL–STD–461D/462D RS103, over the range 10 kHz to 18 GHz. The field strength used shall be 20 V/m, except at the spacecraft transmitter frequencies listed in Table 5.3. At these frequencies the field strength used in the test shall be the predicted value at SMEI plus a 3dB margin.

| Transmitter | Centre Freq (MHz) | Field Strength at SMEI (V/m) | 3 dB BW (MHz) | 60 dB BW (MHz) |
|---------------|-------------------|------------------------------|---------------|----------------|
| LV C–Band | 5765 | 140 | 6 | TBS |
| SGLS (Zenith) | 2212.5 | 30 | 4 | 18 |
| X–Band | 8075 | 20 | 52 | 330 |

Table 5.3 – Spacecraft Transmitter Characteristics

Above 30 MHz the test shall be performed for both vertically and horizontally polarised fields.

The DHU and one Camera shall be located as close together as practicable in the test set–up and the antenna in use shall be at a distance of approximately 1 m from the connector face of the DHU and from the Strong–Box of the Camera.

The test shall be performed with DHU A activated only. DHU B shall **not** be tested.

For the duration of the test, the SMEI instrument and EGSE will be configured and operated as follows:

- Camera Doors will be in *open* position, with the baffle apertures covered by protective bagging.
- Camera Shutters will be in *closed* position.
- The instrument will be operated in *Observing Mode*, with all three cameras taking exposures at the normal 4s cadence.
- The EGSE will be used to acquire and record telemetry data via the appropriate MIL–STD–1553B bus interface at the normal 64 kbps data rate.
- SOH data will be monitored on the EGSE in order to verify that there is no unexpected response, malfunction or degradation in performance of the instrument.

Subsequent to the test, a representative sample of recorded science data will be examined to verify that there is no degradation in performance of the CCD cameras.

Note: The configuration with the Camera Doors open but with the Camera Shutters closed will minimise stray light reaching the CCDs, thereby resulting in maximum sensitivity for detecting degradation in performance of the cameras.

5.2.2.3 Radiated Susceptibility, ESD

The instrument shall be tested in the presence of a 10 kV electrostatic discharge (arc) at a distance of 30 cm and at a rate of 1 to 10 arcs per second for a period of not less than 30 seconds.

The DHU and one Camera shall be located as close together as practicable in the test set-up and the discharge shall be at a distance of approximately 30 cm from the connector face of the DHU and from the Strong-Box of the Camera.

For the duration of the test, the SMEI instrument and EGSE will be configured and operated as follows:

- Camera Doors will be in *open* position, with the baffle apertures covered by protective bagging.
- Camera Shutters will be in *closed* position.
- The instrument will be operated in *Observing Mode*, with all three cameras taking exposures at the normal 4s cadence.
- The EGSE will be used to acquire and record telemetry data via the appropriate MIL-STD-1553B bus interface at the normal 64 kbps data rate.
- SOH data will be monitored on the EGSE in order to verify that there is no unexpected response, malfunction or degradation in performance of the instrument.

Subsequent to the test, a representative sample of recorded science data will be examined to verify that there is no degradation in performance of the CCD cameras.

Note: The configuration with the Camera Doors open but with the Camera Shutters closed will minimise stray light reaching the CCDs, thereby resulting in maximum sensitivity for detecting degradation in performance of the cameras.

6. Summary of Test Requirements

The following summarises the requirements for MIL-STD-461D tests to be performed on the SMEI instrument:

| | | | |
|-------|--------------|----------|-----------------------------------|
| CE101 | Not required | RE101 | Not required (TBC) |
| CE102 | Required | RE102 | Required – enhanced specification |
| CE106 | Not required | RE103 | Not required |
| CS101 | Required | RS101 | Not required (TBC) |
| CS103 | Not required | RS103 | Required |
| CS104 | Not required | RS105 | Not required |
| CS105 | Not required | ESD Test | Required |
| CS109 | Not required | | |
| CS114 | Required | | |
| CS115 | Not required | | |
| CS116 | Not required | | |